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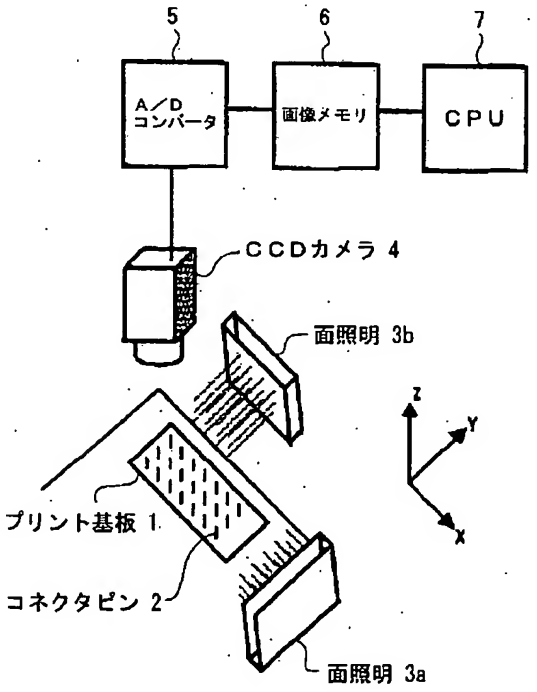
(54)【発明の名称】　光学検査方法及び光学検査装置

(57)【要約】
【課題】　プリント基板１やその他の基材（台座を含む）などに対して略垂直方向に突起が伸びるように、プレスフィットにより圧入されている複数のコネクタピン２などの突起状部材が、所望の形状となるように挿入されているか否かを検査する。
【解決手段】　コネクタピン２などの突起状部材が圧入されているプリント基板１などの基材に対して、一方向から面照明３ａにより光を当てて、その光により作られた基材上に投影された突起状部材の影をＣＣＤカメラ４により撮像する。さらに面照明３ｂにより異なる方向から光を当てて、同様にして突起状部材の影を撮像する。これらの撮像データを基にして画像分析を行い、突起状部材の影の先端位置を検出して突起状部材の形状を判断する。



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【特許請求の範囲】

【請求項１】　基材と、前記基材に対して略垂直方向に突起が伸びるように前記基材上に配設された複数の突起状部位の形状を光学的に検査して、前記突起状部位を有する被検査部材の良否を判定する光学検査方法であって、

前記基材上に前記突起状部位の第１の影を作るために、第１の光源を用いて、前記被検査部材に所定の角度から光を照射するステップと、

前記第１の影を前記基材に対し略垂直な方向から撮像する第１撮像ステップと、

前記第１撮像ステップで撮像された撮像画像から前記第１の影の先端位置を検出するステップと、

前記基材上に前記突起状部位の第２の影を作るために、第２の光源を用いて、前記突起の前記第１撮像ステップで照射される部分とは異なる部分が照射されるよう、前記被検査部材に前記所定の角度とは異なる角度から光を当てるステップと、

前記第２の影を前記基材に対し略垂直な方向から撮像する第２撮像ステップと、

前記第２撮像ステップで撮像された撮像画像から前記第２の影の先端位置を検出するステップと、

検出された前記第１及び第２の影のそれぞれの先端位置に基づいて、前記被検査部材の良／不良を判定するステップとを、

有する光学検査方法。

【請求項２】　前記所定の角度と異なる角度が前記所定の角度と略９０°異なる角度であることを特徴とする請求項１記載の光学検査方法。

【請求項３】　前記第１及び第２の光源が面光源であることを特徴とする請求項１又は２記載の光学検査方法。

【請求項４】　前記突起状部位の影の長さを調節するため、前記突起状部位の間隔及び前記突起状部位の長さを基にして最適な光の向きを算出し、前記最適な光の向きから前記被検査部材を照射するよう前記第１又は第２の光源の位置を自動的に調節することを特徴とする請求項１ないし３のいずれかに記載の光学検査方法。

【請求項５】　基材と、前記基材に対して略垂直方向に突起が伸びるように前記基材上に配設された複数の突起状部位の形状を光学的に検査して、前記突起状部位を有する被検査部材の良否を判定する光学検査方法であって、

前記基材上に前記突起状部位の第１の影を作るために、前記被検査部材に所定の角度から光を照射する第１の照明手段と、

前記基材上に前記突起状部位の第２の影を作るために、前記突起の前記第１撮像ステップで照射される部分とは異なる部分が照射されるよう、前記被検査部材に前記所定の角度とは異なる角度から光を照射する第２の照明手段と、

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前記第１及び第２のそれぞれの影を、前記基材に対し略垂直な方向から撮像するための撮像手段と、

前記撮像手段により撮像された撮像画像から前記第１及び第２の影のそれぞれの先端位置を検出する検出手段と、

検出された前記第１及び第２の影のそれぞれの先端位置に基づいて、前記被検査部材の良／不良を判定する判定手段とを、

有する光学検査装置。

【請求項６】　前記所定の角度と異なる角度が前記所定の角度と略９０°異なる角度であることを特徴とする請求項５記載の光学検査装置。

【請求項７】　前記第１及び第２の照明手段が面光源であることを特徴とする請求項５又は６記載の光学検査装置。

【請求項８】　前記突起状部位の影の長さを調節するため、前記突起状部位の間隔及び前記突起状部位の長さを基にして最適な光の向きを算出し、前記最適な光の向きから前記被検査部材を照射するように前記第１又は第２の照明手段の位置を自動的に調節することを特徴とする請求項５ないし７のいずれかに記載の光学検査装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、基材に２次元的に配設された突起状部材が、所望の位置に存在するかどうかを検査する光学検査方法及び光学検査装置に関し、特に、プレスフィットにおいてコネクタピンがプリント基板のスルーホールに正常に圧入されたか否かを検査するために好適な光学検査方法及び光学検査装置に関する。

【０００２】

【従来の技術】プレスフィットは、プリント基板などの基材（台座などを含む）のスルーホールにコネクタピンなどの突起状部材を圧入する方法である。これにより、例えばハンダを使わずにコネクタピンをプリント基板に固定することが可能となる。２次元的に配設されたスルーホールを有するプリント基板にコネクタピンを挿入することで、コネクタピンはプリント基板上に２次元的に配設される。上記プレスフィットにより、コネクタピンが正常にプリント基板に挿入されたか否かの判定を行うためにプレスフィット検査が行われる。

【０００３】図６は、従来のプレスフィット検査方法の一例を示す模式図である。また、図７は、従来のプレスフィット検査方法の他の一例を示す模式図である。従来のプレスフィット検査方法には、図６のようにＣＣＤカメラ４によって１列ずつ横方向からコネクタピン２を撮像し、その撮像画像を見てコネクタピン２の曲がり及びコネクタピン２の長さを検出する方法と、図７のように上方向からコネクタピン２に照明を当てて、上方向からＣＣＤカメラ４によってコネクタピン２を１本ずつ撮像し、その撮像画像からコネクタピン２の先端を検出し、

コネクタピン2の曲がりを検査する方法とがある。

【0004】また、特許公報第2599812号において、ほぼ同一形状をもち、先端がほぼ一直線上に配列された複数の突起状部位を有する被検査部材を、所定角度で照明して突起状部位の影を作り、その影を撮像した画像から被検査部材の良／不良を判定する光学検査装置が開示されている。これは1次元的に配列された突起状部位の影を撮像して、その撮像画像から製品の良／不良を判定するものである。

【0005】

【発明が解決しようとする課題】図6に示す従来のプレスフィット検査方法では、コネクタピン2などの突起状部材が2次元に配設されている場合、手前のコネクタピンに関しては検査が可能であるが、奥のコネクタピン2に関してはどのコネクタピン2が不良なのかを正確に特定することはできない。また、図7に示す従来のプレスフィット検査方法では、上方向からコネクタピン2を検査するため、コネクタピン2の曲がりは検出できても長さの測定はできず、また、1本1本検査を行うため手間がかかる。さらに、コネクタピン2の形状やプリント基板1などの基材の表面の状態によりコネクタピン2の先端の検出の精度が左右されるので、コネクタピン2の良／不良を確実に判定することは困難である。

【0006】また、図2から分かるように、プリント基板1上に投影されるコネクタピン2の影は、コネクタピン2の長さと、照明からのコネクタピン2への照射角度とによって決まる。したがって、コネクタピン2が2次元的に配設されている場合、コネクタピン2の影がコネクタピン2のピッチ（間隔）より長くなって、その影の先端位置が隣接するコネクタピン2に重なってしまうことも考えられる。特許公報第2599812号において開示されている発明を2次元的に配設されたコネクタピン2を有するプリント基板1に適用すると、コネクタピン2の影がプリント基板1上に投影されるため、隣接したコネクタピン2に重なることがあり、コネクタピン2の良／不良を確実に判定することは困難となる。

【0007】本発明は、2次元的に配設されるようにコネクタピンなどの突起状部材が圧入されているプリント基板やその他の基材に関して、コネクタピンなどの突起状部材が所望の形状となるよう挿入されているか否かを検査することを目的とする。

【0008】

【課題を解決するための手段】上記目的を達成するために、本発明では、コネクタピンなどの突起状部材が圧入されているプリント基板などの基材に対して一方向から光を当てて、基材上に作られた突起状部材の影を撮像する。さらに異なる方向から光を当てて、同様にして突起状部材の影を撮像する。これらの撮像データを基にして画像分析を行い、突起状部材が所望の状態となるよう挿入されているか否かを検査する。また、突起状部材の検査に対して、突起状部材の影の長さ及び方向が最適となるよう突起状部材の影を作る光源の位置を調節する。

【0009】すなわち本発明によれば、基材と、前記基材に対して略垂直方向に突起が伸びるように前記基材上に配設された複数の突起状部位の形状を光学的に検査して、前記突起状部位を有する被検査部材の良否を判定する光学検査方法であって、前記基材上に前記突起状部位の第1の影を作るために、第1の光源を用いて、前記被検査部材に所定の角度から光を照射するステップと、前記第1の影を前記基材に対し略垂直な方向から撮像する第1撮像ステップと、前記第1撮像ステップで撮像された撮像画像から前記第1の影の先端位置を検出するステップと、前記基材上に前記突起状部位の第2の影を作るために、第2の光源を用いて、前記突起の前記第1撮像ステップで照射される部分とは異なる部分が照射されるよう、前記被検査部材に前記所定の角度とは異なる角度から光を当てるステップと、前記第2の影を前記基材に対し略垂直な方向から撮像する第2撮像ステップと、前記第2撮像ステップで撮像された撮像画像から前記第2の影の先端位置を検出するステップと、検出された前記第1及び第2の影のそれぞれの先端位置に基づいて、前記被検査部材の良／不良を判定するステップとを、有する光学検査方法が提供される。この構成により、基材に2次元的に突起状部材が配設されている被検査部材に関して、突起状部材が所望の形状となっているか否かを検査することが可能となる。

【0010】さらに前記所定の角度と異なる角度が前記所定の角度と略90°異なる角度であることを付加することは、本発明の好ましい態様である。また、さらに前記第1及び第2の光源が面光源であることを付加することは本発明の好ましい態様である。また、さらに前記突起状部位の影の長さを調節するため、前記突起状部位の間隔及び前記突起状部位の長さを基にして最適な光の向きを算出し、前記最適な光の向きから前記被検査部材を照射するよう前記第1又は第2の光源の位置を自動的に調節することは、本発明の好ましい態様である。これらの構成により、より精度の高い突起状部材の形状の検査が可能となる。

【0011】また本発明によれば、基材と、前記基材に対して略垂直方向に突起が伸びるように前記基材上に配設された複数の突起状部位の形状を光学的に検査して、前記突起状部位を有する被検査部材の良否を判定する光学検査方法であって、前記基材上に前記突起状部位の第1の影を作るために、前記被検査部材に所定の角度から光を照射する第1の照明手段と、前記基材上に前記突起状部位の第2の影を作るために、前記突起の前記第1撮像ステップで照射される部分とは異なる部分が照射されるよう、前記被検査部材に前記所定の角度とは異なる角度から光を照射する第2の照明手段と、前記第1及び第2のそれぞれの影を、前記基材に対し略垂直な方向から

撮像するための撮像手段と、前記撮像手段により撮像された撮像画像から前記第１及び第２の影のそれぞれの先端位置を検出する検出手段と、検出された前記第１及び第２の影のそれぞれの先端位置に基づいて、前記被検査部材の良／不良を判定する判定手段とを、有する光学検査装置が提供される。この構成により、基材に２次元的に突起状部材が配設されている被検査部材に関して、突起状部材が所望の形状となっているか否かを検査することが可能となる。

【００１２】さらに前記所定の角度と異なる角度が前記所定の角度と略９０°異なる角度であることを付加することは、本発明の好ましい態様である。また、さらに前記第１及び第２の照明手段が面光源であることを付加することは本発明の好ましい態様である。また、さらに前記突起状部位の影の長さを調節するため、前記突起状部位の間隔及び前記突起状部位の長さを基にして最適な光の向きを算出し、前記最適な光の向きから前記被検査部材を照射するように前記第１又は第２の照明手段の位置を自動的に調節することは、本発明の好ましい態様である。これらの構成により、より精度の高い突起状部材の形状の検査が可能となる。

【００１３】

【発明の実施の形態】以下、図面を参照して本発明の光学検査方法及び光学検査装置に係る実施の形態を説明する。図１は、本発明の光学検査方法及び光学検査装置に係る一実施の形態を示す模式図である。２次元的に配設されたスルーホールを有するプリント基板１に、プレスフィット工法によって複数のコネクタピン２（突起状部位）が圧入された被検査部材において、プリント基板１を通過した反対側のコネクタピン２の状態を検査することで、コネクタピン２がプリント基板１に正しく挿入されたか否かを確認する。プリント基板１を通過したコネクタピン２の配列に対して、横から見るとコネクタピン２が重なって見える方向をそれぞれＸ軸、Ｙ軸とする。コネクタピン２はＺ軸方向に突起が伸びている。図１に示すように、面照明３ａ（第１の光源、第１の照明）及び面照明３ｂ（第２の光源、第２の照明）からの光によりＸ軸方向及びＹ軸方向にコネクタピン２の影が作られるようにする。後述のように、面照明３からの光の方向とプリント基板１の面とはΘ_1の角度をなしている。また、図１ではＸ軸方向及びＹ軸方向に影を作るために２つの面照明３を設置しているが、１つの面照明３のみを設置して面照明３又はプリント基板１を略９０°回転させて影を作ることも可能である。また、面照明３ａと面照明３ｂとが異なる方向に影を作れば、理論的にコネクタピン２の形状を検査することは可能であるが、コネクタピン２の影の方向が略９０°となるように面照明３ａ及び面照明３ｂを設置するのが好ましい。

【００１４】ＣＣＤカメラ４がプリント基板１の上方に配設され、このＣＣＤカメラ４によって、プリント基板１上に作られるコネクタピン２の影がプリント基板１に垂直な方向から撮像される。ＣＣＤカメラ４の撮像による画像信号は、Ａ／Ｄコンバータ５により量子化され、２値画像データに変換されて、画像メモリ６に記憶される。これらの処理はＣＰＵ７により制御されて行われる。

【００１５】図２は、本発明の光学検査方法及び光学検査装置に係る面照明からの光によりコネクタピンの影がプリント基板上に投影される様子を示す模式図である。プリント基板１に対して角度Θ_1となるように、面照明３からの光が斜め上方から照射される。これにより、プリント基板１上にコネクタピン２の影が作られ、ＣＣＤカメラ４によってコネクタピン２の影が投影されているプリント基板１が上方向から撮像される。こうして撮像された画像からコネクタピン２の影の先端位置を検出することでコネクタピン２の状態を検査し、コネクタピン２の良／不良を判定する。

【００１６】コネクタピン２に対して異なる２方向から光を照射してコネクタピン２の影をプリント基板１上に作り、ＣＣＤカメラ４でその様子を撮像してその画像を分析することで、どの方向にコネクタピン２が曲がっていても、その曲がりの検出が可能となる。このとき、光を照射する２方向がプリント基板１に平行な面内において異なる方向であれば、コネクタピン２の曲がりの検出は可能であるが、図１に示すように光を照射する２方向を垂直とした場合、コネクタピン２の曲がりの検出の精度が最も高くなる。

【００１７】なお、コネクタピン２の影をプリント基板１上に投影する照明として点光源を用いることも可能であるが、面光源を用いたほうが好ましい。面照明３を用いることにより、エリアとしてＣＣＤカメラ４によって得られた画像内のどの部分においても一定方向にコネクタピン２の影が形成され、エリア内のコネクタピン２を同一条件で検査が可能となる。

【００１８】また、コネクタピン２の影の長さを調節するため、本発明の光学検査方法及び光学検査装置は、Ｘ、Ｙ軸方向それぞれのコネクタピン２のピッチ及びコネクタピン２の長さのデータを基にして、下記の式①を用いてプリント基板に垂直な面内における面照明３からの光の向きの最適な角度を算出し、その最適な角度に設定されるように面照明３の位置を自動的に調節する自動照明垂直面内角度調節手段を有する。なお、これらの照明角度の算出、照明角度の設定はＣＰＵの制御によって行われる。

$$\Theta_1 = \tan\{L/(P-\alpha)\} \quad \cdots ①$$

ただし、Ｌはコネクタピン２の長さ、Ｐはコネクタピン２のピッチ、αは検査余裕のためのバッファ長さである。これにより、コネクタピン２が２次元的に配設されている場合、コネクタピン２の影がコネクタピン２のピッチより長くなって、その影の先端位置が隣接するコネ

クタピン2に重なることを防ぐことができる。

【0019】さらに、面照明3をプリント基板1に平行な面内において移動することにより、コネクタピン2の影の方向を変えることが可能となる。図4は、本発明の光学検査方法及び光学検査装置に係るコネクタピンのX、Y軸方向の配列とは異なる方向に影を作った様子を示す模式図である。図4のように、コネクタピン2の縦横並び（X、Y軸方向）と同一の方向へ光を照射するよりも、斜め方向に光を照射するほうが隣接するコネクタピン2の影響を受けずに長い影を作ることが可能である。このとき、例えば図4に示す4本のコネクタピン2が作る四辺形の内側にコネクタピン2の影を作るならば、四辺形の対角に向かって伸びるように影を作ればコネクタピン2の影が最も長くなり、コネクタピン2の良／不良の判定の精度が向上する。

【0020】また、コネクタピン2の影の方向を調節するため、本発明の光学検査方法及び光学検査装置は、X、Y軸方向それぞれのコネクタピン2のピッチ及びコネクタピン2の長さのデータを基にして、下記の式②を用いてプリント基板に平行な面内における面照明3からの光の向きの最適な角度を算出し、その最適な角度に設定されるように面照明3の位置を自動的に調節する自動照明水平面内角度調節手段を有する。なお、これらの照明角度の算出、照明角度の設定はCPUの制御によって行われる。

$$\Theta_2 = \tan(P_X / P_Y) \quad \cdots ②$$

ただし、P_X、P_Yは、X軸方向、Y軸方向のコネクタピン2のピッチである。

【0021】また、プリント基板1上のコネクタピン2の影が投影される部分に例えば白色の塗装を施してもよい。これにより、照明によってプリント基板1上に投影されるコネクタピン2の影がより明瞭となり、コネクタピン2の良／不良の判定の精度が向上する。

【0022】図3は、コネクタピンの影のパターンを示す模式図である。コネクタピン2の状態は、その影の方向と長さから判断される。図3（a）は、正常に挿入されたコネクタピンの影のパターンを示す模式図である。この正常に挿入されたコネクタピン2の影の先端位置を基準にする。コネクタピン2の影の先端位置が所定の基準を中心とする所定の範囲内にあれば、そのコネクタピン2は正常に挿入されていると判断できる。一方、コネクタピン2の影の先端位置が所定の範囲外にある場合は、そのコネクタピン2は正常に挿入されていないと判断される。図3（b）、「曲がりNG」のコネクタピンの影の一例を示す模式図である。図3（b）に示すように、コネクタピン2の影の方向が基準に対して許容範囲外である場合は「曲がりNG」と判定される。図3（c）は、「挿入深さNG」のコネクタピンの影の一例を示す模式図である。図3（c）に示すように、コネクタピン2の影の長さが許容範囲未満であれば「挿入深さNG」と判定される。図3（d）は、「未挿入NG」のコネクタピンの影の一例を示す模式図である。図3（d）に示すように、コネクタピン2の影が全くない場合は「未挿入NG」と判定される。

【0023】また、本発明の光学検査方法及び光学検査装置では、コネクタピン2がランダムな配列になっていたり、ランダムな長さのコネクタピン2が混在していたりする場合でも、コネクタピン2が正常に挿入されているか否かを検査することが可能である。すなわち、コネクタピン2の影の撮像画像を分析するときに、その影の先端位置が存在すべき所定の範囲を各々のコネクタピン2に関して設定することにより、各コネクタピン2の状態をそれぞれ検査することが可能となる。また、異なる2方向から同時に光を当てて異なる方向にコネクタピン2の影を2本作り、その影の位置を撮像して、その撮像画像を基に異なる2方向の曲がりや歪みなどを検査することも可能である。

【0024】次に、本発明の光学検査方法及び光学検査装置の使用に係るフローチャートに関して説明する。図5は、本発明の光学検査方法及び光学検査装置に係る一実施の形態のフローチャートである。ステップS1において、照明3a（X軸方向）が点灯される。これにより、コネクタピン2の影がX軸方向に作られる。ステップS2において、CCDカメラ4によってプリント基板1上にX軸方向に作られたコネクタピン2の影が上方向から撮像される。この撮像データは、画像メモリ6に記録される。ステップS3において、照明3a（X軸方向）が消灯される。ステップS4において、照明3b（Y軸方向）が点灯される。これにより、コネクタピン2の影がY軸方向に作られる。ステップS5において、プリント基板1上にX軸方向に作られたコネクタピン2の影が、CCDカメラ4によって上方向から撮像され、画像メモリ6に撮像データが記録される。ステップS6において、照明3b（Y軸方向）が消灯される。

【0025】ステップS7において、ステップS2で入力された画像を基に、コネクタピン2の影の先端位置が検出される。その後、ステップS8において、曲がり角度が測定され、ステップS9において、コネクタピン2の影の長さが測定される。ステップS10において、コネクタピン2が正常に挿入されているか否かが判定される。このとき、コネクタピン2が図3に示す「曲がりNG」の状態であるか否か、「挿入深さNG」の状態であるか否か、「未挿入NG」の状態であるか否かが判定される。コネクタピン2が正常に挿入されていないとステップS10で判定された場合、NGと判定されたコネクタピン2（NGピン）の位置とそのNGの項目がステップS11において記録される。以上のステップS7～ステップS11は、ステップS12で全てのコネクタピン2の測定が終了したと判定されるまで行われ、X軸方向に作られた全てのコネクタピン2の影の分析、すなわ

ち、全てのコネクタピン２のＹ軸方向の曲がりや歪みが検査される。

【００２６】ステップＳ１２において、全てのコネクタピン２の測定が終了したと判定されると、続いてステップＳ１３以降のステップが行われる。ステップＳ１３～Ｓ１８では、ステップＳ７～ステップＳ１２と同一のステップが、ステップＳ５で入力された画像に関して行われる。すなわち、全てのコネクタピン２に関して、ステップＳ５で入力された画像を基に、ステップＳ１３でコネクタピン２の影の先端位置が検出され、ステップＳ１４でコネクタピン２の曲がり角度が測定され、ステップＳ１５でコネクタピン２の影の長さが測定され、ステップＳ１６でコネクタピン２が正常に挿入されているか否かが判定される。そしてステップＳ１３～Ｓ１６において、コネクタピン２が正常に挿入されていないと判定された場合、ステップＳ１７において、ＮＧと判定されたコネクタピン２の位置とそのＮＧの項目が記録される。以上のステップＳ１３～ステップＳ１７は、ステップＳ１８で全てのコネクタピン２の測定が終了したと判定されるまで行われ、Ｙ軸方向に作られた全てのコネクタピン２の影の分析、すなわち、全てのコネクタピン２のＸ軸方向の曲がりや歪みが検査される。全てのコネクタピン２の測定が終了した場合、プレスフィット検査は終了となる。

【００２７】コネクタピン２が正常に挿入されていないプリント基板１では、ステップＳ１１又はステップＳ１７でＮＧピンの位置とそのＮＧの項目が記録されている。ＮＧピンの存在するプリント基板１は不良品であり、良品とは別にされる必要があるが、ＮＧの項目によっては、不良品と判定されたプリント基板１は再利用可能である。例えば「曲がりＮＧ」や「挿入深さＮＧ」のコネクタピンは挿入圧や挿入方向などの不具合によって、コネクタピン２の挿入が正常に行われなかったと考えられるので、再度ＮＧピンを挿入し直すことによって、良品を作ることが可能である。一方、「未挿入ＮＧ」と判定されたプリント基板１は、スルーホールの大きさが大きくなってしまっていて、コネクタピン２が固定できないと考えられるので、再利用することは不可能である。

【００２８】本発明の光学検査方法及び光学検査装置において、２つの異なる方向から光を当ててコネクタピン２の影を撮像した撮像データの分析は、それぞれの方向において独立である。したがって、ステップＳ２で画像メモリ６に記録された画像データをステップＳ７～Ｓ１２で分析した後、ステップＳ４及びステップＳ５を行い、ステップＳ５で画像メモリ６に記録された画像データをステップＳ１３～Ｓ１８で分析することも可能である。

【００２９】また、上記実施の形態では、プレスフィットによって２次元的に配設されたスルーホールを有するプリント基板１に圧入されたコネクタピン２の良／不良を検査しているが、本発明はプリント基板１に圧入されたコネクタピン２の良／不良の検査に限定されることなく、薄手の基材やコネクタの台座のようなかさのある基材などに、突起状部材が配設された被検査部材の検査においても適用することが可能である。

【００３０】

【発明の効果】以上説明したように、本発明によれば、コネクタピンなどの突起状部材が圧入されているプリント基板などの基材に対して、一方向から光を当てて、その光により作られた基材上に投影された突起状部材の影をＣＣＤカメラにより撮像し、さらに異なる方向から光を当てて、同様にして突起状部材の影を撮像して、こうして撮像された突起状部材の影から突起状部材の形状を判断するので、基材に対して略垂直方向に突起が伸びるように配設された複数の突起状部材が、所望の形状となるように挿入されているか否かを検査することが可能となる。

【図面の簡単な説明】

【図１】本発明の光学検査方法及び光学検査装置に係る一実施の形態を示す模式図である。

【図２】本発明の光学検査方法及び光学検査装置に係る面照明からの光によりコネクタピンの影がプリント基板上に投影される様子を示す模式図である。

【図３】（ａ）は、正常に挿入されたコネクタピンの影のパターンを示す模式図である。（ｂ）は、「曲がりＮＧ」のコネクタピンの影の一例を示す模式図である。（ｃ）は、「挿入深さＮＧ」のコネクタピンの影の一例を示す模式図である。（ｄ）は、「未挿入ＮＧ」のコネクタピンの影の一例を示す模式図である。

【図４】本発明の光学検査方法及び光学検査装置に係るコネクタピンのＸ、Ｙ軸方向の配列とは異なる方向に影を作った様子を示す模式図である。

【図５】本発明の光学検査方法及び光学検査装置に係る一実施の形態のフローチャートである。

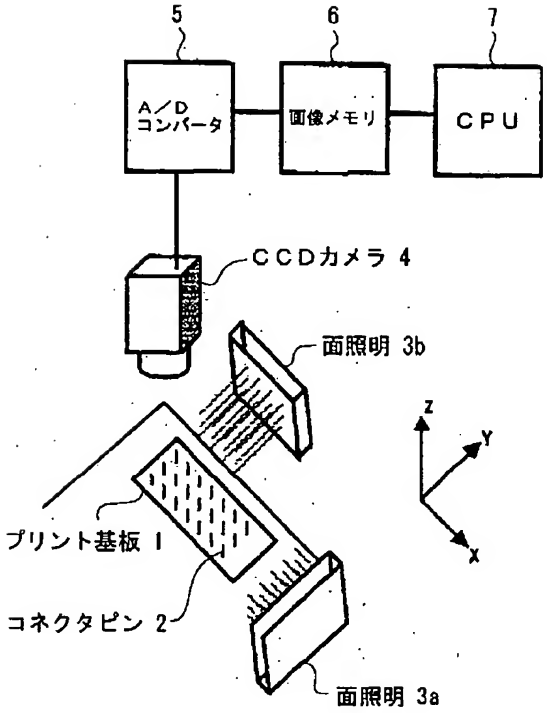
【図６】従来のプレスフィット検査方法の一例を示す模式図である。

【図７】従来のプレスフィット検査方法の他の一例を示す模式図である。

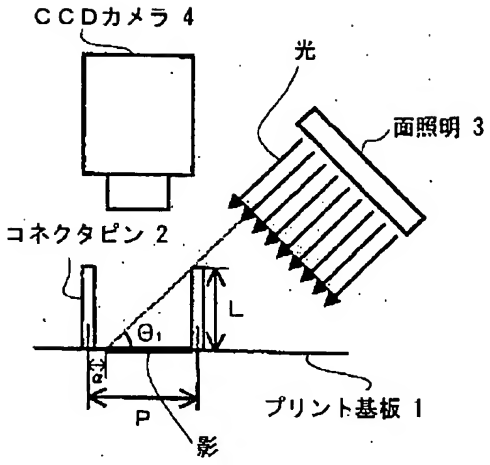
【符号の説明】

１　プリント基板（基材）
２　コネクタピン（突起状部材）
３　面照明
４　ＣＣＤカメラ
５　Ａ／Ｄコンバータ
６　画像メモリ
７　ＣＰＵ

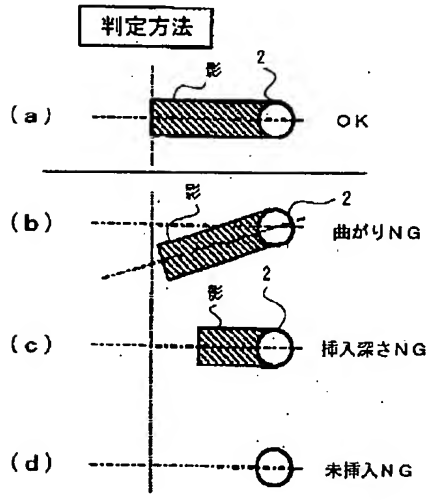
【図1】


5
6
7
A／D
コンバータ
画像メモリ
CPU
CCDカメラ 4
面照明 3b
Z
Y
X
プリント基板 1
コネクタピン 2
面照明 3a

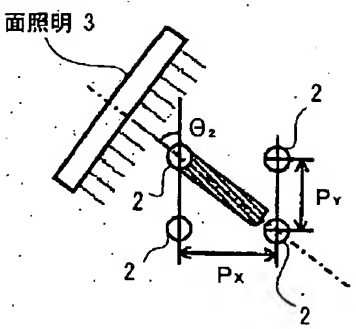
【図2】


CCDカメラ 4
光
面照明 3
コネクタピン 2
L
θ1
P
影
プリント基板 1

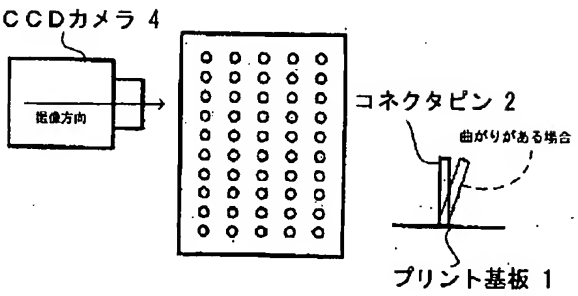
【図3】


判定方法
影
2
(a)
OK
(b)
曲がりNG
(c)
挿入深さNG
(d)
未挿入NG

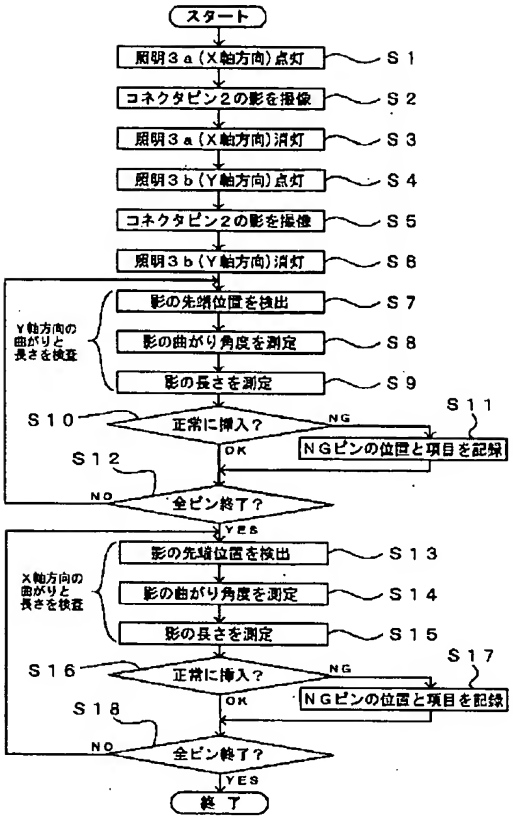
【図4】


面照明 3
θ2
2
Py
Px

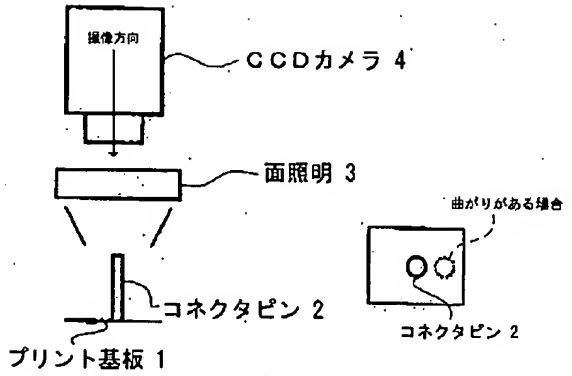
【図6】


CCDカメラ 4
撮像方向
コネクタピン 2
曲がりがある場合
プリント基板 1

【図5】


スタート
照明３ａ（Ｘ軸方向）点灯
Ｓ１
コネクタピン２の影を撮像
Ｓ２
照明３ａ（Ｘ軸方向）消灯
Ｓ３
照明３ｂ（Ｙ軸方向）点灯
Ｓ４
コネクタピン２の影を撮像
Ｓ５
照明３ｂ（Ｙ軸方向）消灯
Ｓ６
Ｙ軸方向の曲がりと長さを検査
影の先端位置を検出
Ｓ７
影の曲がり角度を測定
Ｓ８
影の長さを測定
Ｓ９
Ｓ１０
正常に挿入？
NG
Ｓ１１
ＮＧピンの位置と項目を記録
OK
Ｓ１２
NO
全ピン終了？
YES
Ｘ軸方向の曲がりと長さを検査
影の先端位置を検出
Ｓ１３
影の曲がり角度を測定
Ｓ１４
影の長さを測定
Ｓ１５
Ｓ１６
正常に挿入？
NG
Ｓ１７
ＮＧピンの位置と項目を記録
OK
Ｓ１８
NO
全ピン終了？
YES
終了

【図7】


撮像方向
ＣＣＤカメラ 4
面照明 3
曲がりがある場合
コネクタピン 2
コネクタピン 2
プリント基板 1

DERWENT-ACC-NO: 2002-005374

DERWENT-WEEK: 200201

TITLE: Connector pin press-fitting optical inspection method for printed circuit boards, involves judging quality of press-fitted connector pins based on photographs of shadows obtained by irradiating pins at two angles

PATENT-ASSIGNEE: MATSUSHITA DENKI SANGYO KK[MATU]

PRIORITY-DATA: 2000JP-0099786 (March 31, 2000)

PATENT-FAMILY:

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JP 2001280935 A	October 10, 2001	N/A	008	G01B 011/24

APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
JP2001280935A	N/A	2000JP-0099786	March 31, 2000

INT-CL (IPC): G01B011/24, H05K003/00

ABSTRACTED-PUB-NO: JP2001280935A

BASIC-ABSTRACT:

NOVELTY - The light sources (3a,3b) irradiate light at two different angles on connector pins (2) to form shadows on the printed **circuit board** (1). The end position of each shadow is **detected** from photographic **image** obtained using a **CCD camera** (4). The quality of the press-fitted connector pins is judged based on the end position of the shadows.

DETAILED DESCRIPTION - An INDEPENDENT CLAIM is also included for

optical
inspection apparatus.

USE - For optical inspection of press-fitting of connector pin in printed
circuit board.

ADVANTAGE - The photographed shadows of the pins enable accurate judgment of
the press-fitted pins to the circuit board.

DESCRIPTION OF DRAWING(S) - The figure shows a model of the optical inspection
apparatus. (Drawing includes non-English language text).

Printed circuit board 1

Connector pins 2

Light sources 3a,3b

CCD camera 4

CHOSEN-DRAWING: Dwg.1/7

TITLE-TERMS: CONNECT **PIN PRESS FIT** OPTICAL INSPECT METHOD PRINT CIRCUIT BOARD
JUDGEMENT QUALITY PRESS FIT CONNECT PIN BASED PHOTOGRAPH SHADOW
OBTAIN IRRADIATE PIN TWO ANGLE

DERWENT-CLASS: S02 V04

EPI-CODES: S02-A03B3; V04-R06J1C;

SECONDARY-ACC-NO:
Non-CPI Secondary Accession Numbers: N2002-004464

PATENT ABSTRACTS OF JAPAN

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H05K 3/00

(21)Application number : **2000-099786**

(22)Date of filing : **31.03.2000**

(71)Applicant : **MATSUSHITA ELECTRIC IND CO LTD**

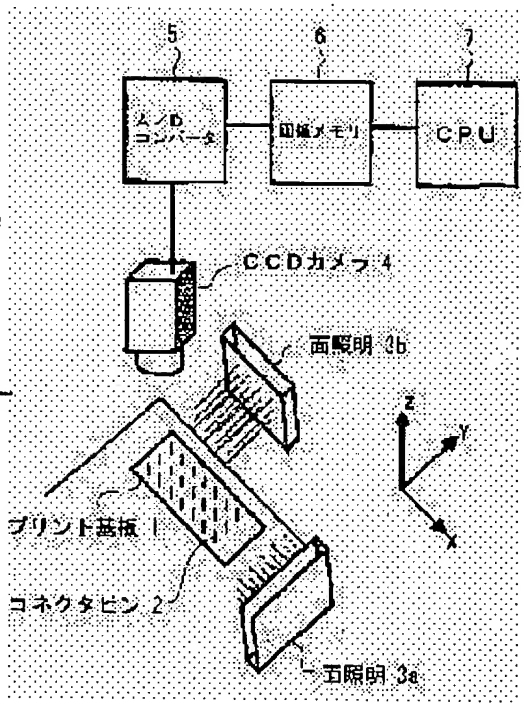
(72)Inventor : **KODAMA TOMOAKI**

(54) METHOD AND DEVICE FOR OPTICAL INSPECTION

(57)Abstract:

PROBLEM TO BE SOLVED: To inspect whether projected members such as plural connector pins 2 pressed in by press fit to extend their projections substantially vertically with respect to a printed circuit board 1 or other base material (including a pedestal) are inserted to be brought into a desiarable shape or not.

SOLUTION: The base material such as the printed circuit board 1 pressed in with the projected members such as the connector pins 2 is irradiated with light from one direction by surface lighting 3a, and shadows, formed by the light, of the projected members projected on the base material are image-picked up by a CCD camera 4. The base material is irradiated with light from a different direction by surface lighting 3b to image-pick up shadows of the projected members by the same manner. Image analysis is conducted based on data image-picked up therein, and tip positions of the shadows of the projected members are detected thereby to judge the shapes of the projected members.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL FIELD

[Field of the Invention] This invention relates to the suitable optical inspection approach and optical test equipment, in order to inspect whether the connector pin was especially pressed fit in the base material normally in the press fit in the through hole of a printed circuit board about the optical inspection approach and optical test equipment which inspect whether the letter member of a projection arranged two-dimensional exists in a desired location.

[Translation done.]

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PRIOR ART

[Description of the Prior Art] A press fit is the approach of pressing letter members of a projection, such as a connector pin, fit in the through hole of base materials (a plinth etc. is included), such as a printed circuit board. It enables this to fix a connector pin to a printed circuit board, without using a pewter. By inserting a connector pin in the printed circuit board which has the through hole arranged two-dimensional, a connector pin is arranged two-dimensional on a printed circuit board. In order to judge whether the connector pin was normally inserted in the printed circuit board by the above-mentioned press fit, press fit inspection is conducted.
[0003] Drawing 6 is the mimetic diagram showing an example of the conventional press fit inspection approach. Moreover, drawing 7 is the mimetic diagram showing other examples of the conventional press fit inspection approach. How to picturize one train of connector pins 2 at a time from a longitudinal direction, to see the image pick-up image, and to detect the deflection of the connector pin 2, and the die length of the connector pin 2 with CCD camera 4 like drawing 6 in the conventional press fit inspection approach, Lighting is applied to the connector pin 2 from above like drawing 7 , it picturizes one connector pin 2 at a time with CCD camera 4 from above, the tip of the connector pin 2 is detected from the image pick-up image, and there is a method of inspecting the deflection of the connector pin 2.
[0004] Moreover, in the patent official report No. 2599812, it has the same configuration mostly, and the inspected member which has two or more letter parts of a projection where the tip was arranged on about 1 straight line is illuminated at a predetermined include angle, the shadow of the letter part of a projection is made, and the optical test equipment which judges the good/defect of an inspected member from the image which picturized the shadow is indicated. This picturizes the shadow of the letter part of a projection arranged in one dimension, and judges the good/defect of a product from the image pick-up image.

[Translation done.]

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] Although it can inspect about a front connector pin by the conventional press fit inspection approach shown in drawing 6 when letter members of a projection, such as the connector pin 2, are arranged in two-dimensional, about the back connector pin 2, it cannot specify correctly which connector pin 2 is a defect. Moreover, by the conventional press fit inspection approach shown in drawing 7 , since the connector pin 2 is inspected from above, even if the deflection of the connector pin 2 is detectable, in order that measurement of die length cannot be performed and may conduct 1 inspection [1], it requires time and effort. Furthermore, since the precision of detection at the tip of the connector pin 2 is influenced by the condition of the front face of base materials, such as a configuration of the connector pin 2, and a printed circuit board 1, it is difficult to judge certainly the good/defect of the connector pin 2.
[0006] Moreover, the shadow of the connector pin 2 projected on a printed circuit board 1 is decided by whenever [to the connector pin 2 from lighting / die-length / of the connector pin 2 /, and illuminating-angle] so that drawing 2 may show. Therefore, when the connector pin 2 is arranged two-dimensional, the shadow of the connector pin 2 becoming longer than the pitch (spacing) of the connector pin 2, and lapping with the connector pin 2 by which the tip location of the shadow adjoins is also considered. If it applies to the printed circuit board 1 which has the connector pin 2 arranged two-dimensional in invention currently indicated in the patent official report No. 2599812, since the shadow of the connector pin 2 will be projected on a printed circuit board 1, it becomes difficult to lap with the adjoining connector pin 2 and to judge certainly the good/defect of the connector pin 2.
[0007] It aims at inspecting whether about the base material of the printed circuit board in which letter members of a projection, such as a connector pin, are pressed fit so that it may be arranged two-dimensional, or others, this invention is inserted so that letter members of a projection, such as a connector pin, may serve as a desired configuration.

[Translation done.]

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EFFECT OF THE INVENTION

[Effect of the Invention] As opposed to base materials, such as a printed circuit board in which letter members of a projection, such as a connector pin, are pressed fit according to this invention as explained above Apply light from an one direction, picturize the shadow of the letter member of a projection projected on the base material made by the light with a CCD camera, apply light from a further different direction, and the shadow of the letter member of a projection is picturized similarly. In this way, since the configuration of the letter member of a projection is judged from the shadow of the picturized letter member of a projection, two or more letter members of a projection arranged so that a projection might be extended to an abbreviation perpendicular direction to a base material become possible [inspecting whether it is inserted so that it may become a desired configuration].

[Translation done.]

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MEANS

[Means for Solving the Problem] In order to attain the above-mentioned purpose, light is put in this invention from an one direction to base materials, such as a printed circuit board in which letter members of a projection, such as a connector pin, are pressed fit, and the shadow of the letter member of a projection made on the base material is picturized. Light is applied from a direction different furthermore and the shadow of the letter member of a projection is picturized similarly. Image analysis is performed based on these image pick-up data, and it inspects whether it is inserted so that the letter member of a projection may be in a desired condition. Moreover, the location of the light source which makes the shadow of the letter member of a projection so that the die length and the direction of a shadow of the letter member of a projection may become the optimal is adjusted to inspection of the letter member of a projection.

[0009] Namely, according to this invention, the configuration of two or more letter parts of a projection arranged on said base material so that a projection might be extended to an abbreviation perpendicular direction to a base material and said base material is inspected optically. In order to be the optical inspection approach of judging the quality of the inspected member which has said letter part of a projection and to make the 1st shadow of said letter part of a projection on said base material The step which irradiates light from a predetermined include angle at said inspected member using the 1st light source, said 1st shadow -- said base material -- receiving -- abbreviation -- with the 1st image pick-up step picturized from a perpendicular direction In order to make the 2nd shadow of said letter part of a projection from the image pick-up image picturized at said 1st image pick-up step the step which detects the tip location of said 1st shadow, and on said base material So that a different part from the part irradiated at said 1st image pick-up step of said projection may be irradiated using the 2nd light source The step which applies light from an include angle which is different from said predetermined include angle in said inspected member, said 2nd shadow -- said base material -- receiving -- abbreviation -- with the 2nd image pick-up step picturized from a perpendicular direction The optical inspection approach of having the step which detects the tip location of said 2nd shadow from the image pick-up image picturized at said 2nd image pick-up step, and the step which judges the good/defect of said inspected member based on each tip location of said 1st and 2nd detected shadows is offered. It becomes possible to inspect whether by this configuration, the letter member of a projection serves as a desired configuration about the inspected member in which the letter member of a projection is arranged by the base material two-dimensional.

[0010] Furthermore, it is a mode with desirable this invention to add that different include angles from said predetermined include angle are said predetermined include angle and an include angle different [90 degrees of abbreviation]. Furthermore, it is the desirable mode of this invention to add that said 1st and 2nd light sources are the surface light source. Furthermore, it is the desirable mode of this invention to adjust automatically the location of said 1st or 2nd light source so that the sense of the optimal light may be computed based on spacing of said letter part of a projection and the die length of said letter part of a projection and said inspected member may be irradiated from the sense of said optimal light, in order to adjust the die length of the shadow of said letter part of a projection. By these configurations, inspection of the configuration of the letter member of a projection with a more high precision is attained.

[0011] Moreover, according to this invention, the configuration of two or more letter parts of a projection arranged on said base material so that a projection might be extended to an abbreviation perpendicular direction to a base material and said base material is inspected optically. In order to be the optical inspection approach of judging the quality of the inspected member which has said letter part of a projection and to make the 1st shadow of said letter part of a projection on said base material In order to make the 2nd shadow of said letter part of a projection from a predetermined include angle to said inspected member the 1st lighting means which irradiates light, and on said base material So that a different part from the part irradiated at said 1st image pick-up step of said projection may be

irradiated The 2nd lighting means which irradiates light from an include angle which is different from said predetermined include angle in said inspected member, said each 1st and 2nd shadows -- said base material -- receiving -- abbreviation -- with the image pick-up means for picturizing from a perpendicular direction A detection means to detect each tip location of said 1st and 2nd shadows from the image pick-up image picturized by said image pick-up means, Based on each tip location of said 1st and 2nd detected shadows, the optical test equipment which has a judgment means to judge the good/defect of said inspected member is offered. It becomes possible to inspect whether by this configuration, the letter member of a projection serves as a desired configuration about the inspected member in which the letter member of a projection is arranged by the base material two-dimensional.

[0012] Furthermore, it is a mode with desirable this invention to add that different include angles from said predetermined include angle are said predetermined include angle and an include angle different [90 degrees of abbreviation]. Furthermore, it is the desirable mode of this invention to add that said 1st and 2nd lighting means are the surface light source. Furthermore, it is the desirable mode of this invention to adjust automatically the location of said 1st or 2nd lighting means so that the sense of the optimal light may be computed based on spacing of said letter part of a projection and the die length of said letter part of a projection and said inspected member may be irradiated from the sense of said optimal light, in order to adjust the die length of the shadow of said letter part of a projection. By these configurations, inspection of the configuration of the letter member of a projection with a more high precision is attained.

[0013]

[Embodiment of the Invention] Hereafter, the gestalt of the operation which relates to the optical inspection approach and optical test equipment of this invention with reference to a drawing is explained. Drawing 1 is the mimetic diagram showing the gestalt of the 1 operation concerning the optical inspection approach and optical test equipment of this invention. It is checked whether the connector pin 2 has been correctly inserted in a printed circuit board 1 by inspecting the condition of the connector pin 2 of the opposite side of having passed the printed circuit board 1 in the inspected member in which two or more connector pins 2 (letter part of a projection) were pressed fit with the press fit method of construction to the printed circuit board 1 which has the through hole arranged two-dimensional. To the array of the connector pin 2 which passed the printed circuit board 1, if it sees from width, the X-axis and a Y-axis will be set as the direction the connector pin 2 laps and appears, respectively. As for the connector pin 2, the projection is extended to Z shaft orientations. As shown in drawing 1 , the shadow of the connector pin 2 is made by X shaft orientations and Y shaft orientations by the light from area-light 3a (the 1st light source, the 1st lighting) and area-light 3b (the 2nd light source, the 2nd lighting). Like the after-mentioned, the direction of the light from an area light 3 and the field of a printed circuit board 1 are making the include angle of theta 1. Moreover, although two area lights 3 are installed in order to make a shadow from drawing 1 to X shaft orientations and Y shaft orientations, it is also possible to install only one area light 3, to rotate an area light 3 or a printed circuit board 1 90 degrees of abbreviation, and to make a shadow. Moreover, although it is possible to inspect the configuration of the connector pin 2 theoretically if a shadow is made in the direction in which area-light 3a differs from area-light 3b, it is desirable to install area-light 3a and area-light 3b so that the direction of the shadow of the connector pin 2 may serve as 90 degrees of abbreviation.

[0014] CCD camera 4 is arranged above a printed circuit board 1, and the shadow of the connector pin 2 made on a printed circuit board 1 by this CCD camera 4 is picturized from a direction perpendicular to a printed circuit board 1. A/D converter 5 quantizes, and the picture signal by the image pick-up of CCD camera 4 is changed into binary image data, and is memorized in an image memory 6. These processings are performed by being controlled by CPU7.

[0015] Drawing 2 is the mimetic diagram showing signs that the shadow of a connector pin is projected on a printed circuit board by the light from the area light concerning the optical inspection approach and optical test equipment of this invention. The light from an area light 3 is irradiated from the slanting upper part so that it may become an include angle theta 1 to a printed circuit board 1. Thereby, the shadow of the connector pin 2 is made on a printed circuit board 1, and the printed circuit board 1 on which the shadow of the connector pin 2 is projected by CCD camera 4 is picturized from above. In this way, the condition of the connector pin 2 is inspected by detecting the tip location of the shadow of the connector pin 2 from the picturized image, and the good/defect of the connector pin 2 are judged.

[0016] Light is irradiated from a different 2-way to the connector pin 2, and the shadow of the connector pin 2 is made on a printed circuit board 1, and by picturizing the situation with CCD camera 4, and analyzing the image, even if the connector pin 2 has bent in which direction, it becomes detectable [the deflection]. When the 2-way which irradiates light was a different direction in a field parallel to a printed circuit board 1 at this time and the 2-way which irradiates light is made perpendicular as shown in drawing 1 although detection of the deflection of the connector pin 2 is possible, the precision of detection of the deflection of the connector pin 2 becomes the highest.

[0017] In addition, it is more desirable to use the surface light source, although it is also possible to use the point light

source as lighting which projects the shadow of the connector pin 2 on a printed circuit board 1. By using an area light 3, in every part in the image obtained by CCD camera 4 as area, the shadow of the connector pin 2 is formed in the fixed direction, and inspection becomes possible on the same conditions about the connector pin 2 in area.

[0018] In order to adjust the die length of the shadow of the connector pin 2, moreover, the optical inspection approach and optical test equipment of this invention It carries out based on the data of the pitch of the connector pin 2 of X and each Y shaft orientations, and the die length of the connector pin 2. An include angle with the optimal sense of the light from the area light 3 within a field perpendicular to a printed circuit board is computed by using following formula **, and it has an accommodation means whenever [automatic lighting vertical plane interior angle / which adjusts the location of an area light 3 automatically so that it may be set as the optimal include angle]. In addition, calculation of these lighting include angles and a setup of a lighting include angle are performed by control of CPU.

theta1=tan {L/(P-alpha)} -- **, however L are [the pitch of the connector pin 2 and alpha of the die length of the connector pin 2 and P] the buffer die length for inspection allowances. Thereby, when the connector pin 2 is arranged two-dimensional, the shadow of the connector pin 2 becomes longer than the pitch of the connector pin 2, and it can prevent lapping with the connector pin 2 by which the tip location of the shadow adjoins.

[0019] Furthermore, it becomes possible by moving an area light 3 into a field parallel to a printed circuit board 1 to change the direction of the shadow of the connector pin 2. Drawing 4 is the mimetic diagram showing signs that the array of X of the connector pin concerning the optical inspection approach and optical test equipment of this invention and Y shaft orientations made the shadow in the different direction. Like drawing 4 , it is more possible to make a long shadow, without being influenced of the connector pin 2 by which the way which irradiates light adjoins in the direction of slant rather than irradiating light in the same direction as the list (X, Y shaft orientations) of the connector pin 2 in every direction. If the shadow of the connector pin 2 is made inside the quadrilateral which four connector pins 2 shown at this time, for example, drawing 4 , make, and a shadow is made so that it may be extended toward the vertical angle of a quadrilateral, the shadow of the connector pin 2 will become the longest and the precision of a judgment of the good/defect of the connector pin 2 will improve.

[0020] In order to adjust the direction of the shadow of the connector pin 2, moreover, the optical inspection approach and optical test equipment of this invention It carries out based on the data of the pitch of the connector pin 2 of X and each Y shaft orientations, and the die length of the connector pin 2. An include angle with the optimal sense of the light from the area light 3 within a field parallel to a printed circuit board is computed by using following formula **, and it has an accommodation means whenever [automatic lighting horizontal plane interior angle / which adjusts the location of an area light 3 automatically so that it may be set as the optimal include angle]. In addition, calculation of these lighting include angles and a setup of a lighting include angle are performed by control of CPU.

theta2=tan (PX/PY) -- **, however PX and PY are the pitches of the connector pin 2 of X shaft orientations and Y shaft orientations.

[0021] Moreover, white may be painted into the part on which the shadow of the connector pin 2 on a printed circuit board 1 is projected. Thereby, with lighting, the shadow of the connector pin 2 projected on a printed circuit board 1 becomes clearer, and the precision of a judgment of the good/defect of the connector pin 2 improves.

[0022] Drawing 3 is the mimetic diagram showing the pattern of the shadow of a connector pin. The condition of the connector pin 2 is judged from the direction and die length of the shadow. Drawing 3 (a) is the mimetic diagram showing the pattern of the shadow of the connector pin inserted normally. It is based on the tip location of the shadow of this connector pin 2 inserted normally. If the tip location of the shadow of the connector pin 2 is within the limits of predetermined [centering on predetermined criteria], it can be judged that the connector pin 2 is inserted normally. On the other hand, when there is a tip location of the shadow of the connector pin 2 out of range [predetermined], it is judged that the connector pin 2 is not inserted normally. It is the mimetic diagram showing an example of the shadow of the connector pin of drawing 3 (b) and "deflection NG." As shown in drawing 3 (b), when the direction of the shadow of the connector pin 2 is outside tolerance to criteria, it is judged with "deflection NG." Drawing 3 (c) is the mimetic diagram showing an example of the shadow of the connector pin of "immersion-depth NG." With [as shown in drawing 3 (c) / the die length of the shadow of the connector pin 2] tolerance [under], it is judged with "immersion-depth NG." Drawing 3 (d) is the mimetic diagram showing an example of the shadow of the connector pin which "is not inserted [NG]." As shown in drawing 3 (d), when there is no shadow of the connector pin 2, it is judged with "Un-inserting [NG]."

[0023] Moreover, even when the connector pin 2 is a random array in the optical inspection approach and optical test equipment of this invention or the connector pin 2 of random die length is intermingled, it is possible to inspect whether the connector pin 2 is inserted normally. That is, when analyzing the image pick-up image of the shadow of the connector pin 2, it becomes possible to inspect the condition of each connector pin 2, respectively by setting up the

predetermined range where the tip location of the shadow should exist about each connector pin 2. Moreover, it is also possible to make two shadows of the connector pin 2 from a different 2-way in the direction which applies light to coincidence and is different, to picturize the location of the shadow, and to inspect the deflection of a different 2-way based on the image pick-up image, distortion, etc.

[0024] Next, the flow chart concerning use of the optical inspection approach of this invention and optical test equipment is explained. Drawing 5 is the flow chart of the gestalt of the 1 operation concerning the optical inspection approach and optical test equipment of this invention. In step S1, lighting 3a (X shaft orientations) is turned on. Thereby, the shadow of the connector pin 2 is made by X shaft orientations. In step S2, the shadow of the connector pin 2 made by X shaft orientations on the printed circuit board 1 with CCD camera 4 is picturized from above. This image pick-up data is recorded on an image memory 6. In step S3, lighting 3a (X shaft orientations) is switched off. In step S4, lighting 3b (Y shaft orientations) is turned on. Thereby, the shadow of the connector pin 2 is made by Y shaft orientations. In step S5, the shadow of the connector pin 2 made by X shaft orientations on the printed circuit board 1 is picturized from above by CCD camera 4, and image pick-up data are recorded on an image memory 6. In step S6, lighting 3b (Y shaft orientations) is switched off.

[0025] In step S7, the tip location of the shadow of the connector pin 2 is detected based on the image inputted at step S2. Then, in step S8, whenever [corner of a street] is measured and the die length of the shadow of the connector pin 2 is measured in step S9. It is judged in step S10 whether the connector pin 2 is inserted normally. At this time, it is judged whether the connector pin 2 is in the condition of "deflection NG" shown in drawing 3 , whether it is in the condition of "immersion-depth NG", and whether it is in the condition of "not inserting [NG]." When the connector pin 2 was not inserted normally and it is judged at step S10, the location and the item of NG of the connector pin 2 (NG pin) judged to be NG are recorded in step S11. It is carried out until it is judged with measurement of all the connector pins 2 having ended the above step S7 - step S11 at step S12, and the deflection of analysis of the shadow of all the connector pins 2 made by X shaft orientations, i.e., Y shaft orientations of all the connector pins 2, and distortion are inspected.

[0026] In step S12, if judged with measurement of all the connector pins 2 having been completed, the step after step S13 will be performed continuously. At steps S13-S18, the same step as step S7 - step S12 is performed about the image inputted at step S5. That is, about all the connector pins 2, based on the image inputted at step S5, the tip location of the shadow of the connector pin 2 is detected at step S13, whenever [corner of a street / of the connector pin 2] is measured at step S14, the die length of the shadow of the connector pin 2 is measured at step S15, and it is judged whether the connector pin 2 is normally inserted at step S16. And in steps S13-S16, when judged with the connector pin 2 not being inserted normally, in step S17, the location and the item of NG of the connector pin 2 judged to be NG are recorded. It is carried out until it is judged with measurement of all the connector pins 2 having ended the above step S13 - step S17 at step S18, and the deflection of analysis of the shadow of all the connector pins 2 made by Y shaft orientations, i.e., X shaft orientations of all the connector pins 2, and distortion are inspected. When measurement of all the connector pins 2 is completed, press fit inspection is ended.

[0027] By the printed circuit board 1 in which the connector pin 2 is not inserted normally, the location and the item of NG of NG pin are recorded at step S11 or step S17. Although the printed circuit board 1 in which NG pin exists is a defective and it needs to be made different from an excellent article, the printed circuit board 1 judged depending on the item of NG to be a defective is reusable. For example, since the connector pin of "deflection NG" and "immersion-depth NG" is considered that insertion of the connector pin 2 was not performed normally by the fault of insertion pressure, the path of insertion, etc., it can make an excellent article by reinserting NG pin again. It is impossible to reuse on the other hand, since it is thought that the magnitude of a through hole is large and the printed circuit board 1 judged "Un-inserting [NG]" cannot fix the connector pin 2.

[0028] In the optical inspection approach and optical test equipment of this invention, analysis of the image pick-up data which applied light from two different directions and picturized the shadow of the connector pin 2 is independent in each direction. Therefore, after analyzing the image data recorded on the image memory 6 at step S2 at steps S7-S12, it is also possible to analyze the image data which performed step S4 and step S5, and was recorded on the image memory 6 at step S5 at steps S13-S18.

[0029] Moreover, although the good/defect of the connector pin 2 pressed fit in the printed circuit board 1 which has the through hole arranged by the press fit two-dimensional are inspected with the gestalt of the above-mentioned implementation This invention can be applied to a thin base material, a base material with bulk like the plinth of a connector, etc. also in inspection of the inspected member in which the letter member of a projection was arranged, without being limited to inspection of the good/defect of the connector pin 2 pressed fit in the printed circuit board 1.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the suitable optical inspection approach and optical test equipment, in order to inspect whether the connector pin was especially pressed fit in the base material normally in the press fit in the through hole of a printed circuit board about the optical inspection approach and optical test equipment which inspect whether the letter member of a projection arranged two-dimensional exists in a desired location.
[0002]
[Description of the Prior Art] A press fit is the approach of pressing letter members of a projection, such as a connector pin, fit in the through hole of base materials (a plinth etc. is included), such as a printed circuit board. It enables this to fix a connector pin to a printed circuit board, without using a pewter. By inserting a connector pin in the printed circuit board which has the through hole arranged two-dimensional, a connector pin is arranged two-dimensional on a printed circuit board. In order to judge whether the connector pin was normally inserted in the printed circuit board by the above-mentioned press fit, press fit inspection is conducted.
[0003] Drawing 6 is the mimetic diagram showing an example of the conventional press fit inspection approach. Moreover, drawing 7 is the mimetic diagram showing other examples of the conventional press fit inspection approach. How to picturize one train of connector pins 2 at a time from a longitudinal direction, to see the image pick-up image, and to detect the deflection of the connector pin 2, and the die length of the connector pin 2 with CCD camera 4 like drawing 6 in the conventional press fit inspection approach, Lighting is applied to the connector pin 2 from above like drawing 7 , it picturizes one connector pin 2 at a time with CCD camera 4 from above, the tip of the connector pin 2 is detected from the image pick-up image, and there is a method of inspecting the deflection of the connector pin 2.
[0004] Moreover, in the patent official report No. 2599812, it has the same configuration mostly, and the inspected member which has two or more letter parts of a projection where the tip was arranged on about 1 straight line is illuminated at a predetermined include angle, the shadow of the letter part of a projection is made, and the optical test equipment which judges the good/defect of an inspected member from the image which picturized the shadow is indicated. This picturizes the shadow of the letter part of a projection arranged in one dimension, and judges the good/defect of a product from the image pick-up image.
[0005]
[Problem(s) to be Solved by the Invention] Although it can inspect about a front connector pin by the conventional press fit inspection approach shown in drawing 6 when letter members of a projection, such as the connector pin 2, are arranged in two-dimensional, about the back connector pin 2, it cannot specify correctly which connector pin 2 is a defect. Moreover, by the conventional press fit inspection approach shown in drawing 7 , since the connector pin 2 is inspected from above, even if the deflection of the connector pin 2 is detectable, in order that measurement of die length cannot be performed and may conduct 1 inspection [1], it requires time and effort. Furthermore, since the precision of detection at the tip of the connector pin 2 is influenced by the condition of the front face of base materials, such as a configuration of the connector pin 2, and a printed circuit board 1, it is difficult to judge certainly the good/defect of the connector pin 2.
[0006] Moreover, the shadow of the connector pin 2 projected on a printed circuit board 1 is decided by whenever [to the connector pin 2 from lighting / die-length / of the connector pin 2 /, and illuminating-angle] so that drawing 2 may show. Therefore, when the connector pin 2 is arranged two-dimensional, the shadow of the connector pin 2 becoming longer than the pitch (spacing) of the connector pin 2, and lapping with the connector pin 2 by which the tip location of the shadow adjoins is also considered. If it applies to the printed circuit board 1 which has the connector pin 2 arranged two-dimensional in invention currently indicated in the patent official report No. 2599812, since the shadow of the

connector pin 2 will be projected on a printed circuit board 1, it becomes difficult to lap with the adjoining connector pin 2 and to judge certainly the good/defect of the connector pin 2.

[0007] It aims at inspecting whether about the base material of the printed circuit board in which letter members of a projection, such as a connector pin, are pressed fit so that it may be arranged two-dimensional, or others, this invention is inserted so that letter members of a projection, such as a connector pin, may serve as a desired configuration.

[0008]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, light is put in this invention from an one direction to base materials, such as a printed circuit board in which letter members of a projection, such as a connector pin, are pressed fit, and the shadow of the letter member of a projection made on the base material is picturized. Light is applied from a direction different furthermore and the shadow of the letter member of a projection is picturized similarly. Image analysis is performed based on these image pick-up data, and it inspects whether it is inserted so that the letter member of a projection may be in a desired condition. Moreover, the location of the light source which makes the shadow of the letter member of a projection so that the die length and the direction of a shadow of the letter member of a projection may become the optimal is adjusted to inspection of the letter member of a projection.

[0009] Namely, according to this invention, the configuration of two or more letter parts of a projection arranged on said base material so that a projection might be extended to an abbreviation perpendicular direction to a base material and said base material is inspected optically. In order to be the optical inspection approach of judging the quality of the inspected member which has said letter part of a projection and to make the 1st shadow of said letter part of a projection on said base material The step which irradiates light from a predetermined include angle at said inspected member using the 1st light source, said 1st shadow -- said base material -- receiving -- abbreviation -- with the 1st image pick-up step picturized from a perpendicular direction In order to make the 2nd shadow of said letter part of a projection from the image pick-up image picturized at said 1st image pick-up step the step which detects the tip location of said 1st shadow, and on said base material So that a different part from the part irradiated at said 1st image pick-up step of said projection may be irradiated using the 2nd light source The step which applies light from an include angle which is different from said predetermined include angle in said inspected member, said 2nd shadow -- said base material -- receiving -- abbreviation -- with the 2nd image pick-up step picturized from a perpendicular direction The optical inspection approach of having the step which detects the tip location of said 2nd shadow from the image pick-up image picturized at said 2nd image pick-up step, and the step which judges the good/defect of said inspected member based on each tip location of said 1st and 2nd detected shadows is offered. It becomes possible to inspect whether by this configuration, the letter member of a projection serves as a desired configuration about the inspected member in which the letter member of a projection is arranged by the base material two-dimensional.

[0010] Furthermore, it is a mode with desirable this invention to add that different include angles from said predetermined include angle are said predetermined include angle and an include angle different [90 degrees of abbreviation]. Furthermore, it is the desirable mode of this invention to add that said 1st and 2nd light sources are the surface light source. Furthermore, it is the desirable mode of this invention to adjust automatically the location of said 1st or 2nd light source so that the sense of the optimal light may be computed based on spacing of said letter part of a projection and the die length of said letter part of a projection and said inspected member may be irradiated from the sense of said optimal light, in order to adjust the die length of the shadow of said letter part of a projection. By these configurations, inspection of the configuration of the letter member of a projection with a more high precision is attained.

[0011] Moreover, according to this invention, the configuration of two or more letter parts of a projection arranged on said base material so that a projection might be extended to an abbreviation perpendicular direction to a base material and said base material is inspected optically. In order to be the optical inspection approach of judging the quality of the inspected member which has said letter part of a projection and to make the 1st shadow of said letter part of a projection on said base material In order to make the 2nd shadow of said letter part of a projection from a predetermined include angle to said inspected member the 1st lighting means which irradiates light, and on said base material So that a different part from the part irradiated at said 1st image pick-up step of said projection may be irradiated The 2nd lighting means which irradiates light from an include angle which is different from said predetermined include angle in said inspected member, said each 1st and 2nd shadows -- said base material -- receiving -- abbreviation -- with the image pick-up means for picturizing from a perpendicular direction A detection means to detect each tip location of said 1st and 2nd shadows from the image pick-up image picturized by said image pick-up means, Based on each tip location of said 1st and 2nd detected shadows, the optical test equipment which has a judgment means to judge the good/defect of said inspected member is offered. It becomes possible to inspect whether

by this configuration, the letter member of a projection serves as a desired configuration about the inspected member in which the letter member of a projection is arranged by the base material two-dimensional.
[0012] Furthermore, it is a mode with desirable this invention to add that different include angles from said predetermined include angle are said predetermined include angle and an include angle different [90 degrees of abbreviation]. Furthermore, it is the desirable mode of this invention to add that said 1st and 2nd lighting means are the surface light source. Furthermore, it is the desirable mode of this invention to adjust automatically the location of said 1st or 2nd lighting means so that the sense of the optimal light may be computed based on spacing of said letter part of a projection and the die length of said letter part of a projection and said inspected member may be irradiated from the sense of said optimal light, in order to adjust the die length of the shadow of said letter part of a projection. By these configurations, inspection of the configuration of the letter member of a projection with a more high precision is attained.
[0013]
[Embodiment of the Invention] Hereafter, the gestalt of the operation which relates to the optical inspection approach and optical test equipment of this invention with reference to a drawing is explained. Drawing 1 is the mimetic diagram showing the gestalt of the 1 operation concerning the optical inspection approach and optical test equipment of this invention. It is checked whether the connector pin 2 has been correctly inserted in a printed circuit board 1 by inspecting the condition of the connector pin 2 of the opposite side of having passed the printed circuit board 1 in the inspected member in which two or more connector pins 2 (letter part of a projection) were pressed fit with the press fit method of construction to the printed circuit board 1 which has the through hole arranged two-dimensional. To the array of the connector pin 2 which passed the printed circuit board 1, if it sees from width, the X-axis and a Y-axis will be set as the direction the connector pin 2 laps and appears, respectively. As for the connector pin 2, the projection is extended to Z shaft orientations. As shown in drawing 1 , the shadow of the connector pin 2 is made by X shaft orientations and Y shaft orientations by the light from area-light 3a (the 1st light source, the 1st lighting) and area-light 3b (the 2nd light source, the 2nd lighting). Like the after-mentioned, the direction of the light from an area light 3 and the field of a printed circuit board 1 are making the include angle of theta 1. Moreover, although two area lights 3 are installed in order to make a shadow from drawing 1 to X shaft orientations and Y shaft orientations, it is also possible to install only one area light 3, to rotate an area light 3 or a printed circuit board 1 90 degrees of abbreviation, and to make a shadow. Moreover, although it is possible to inspect the configuration of the connector pin 2 theoretically if a shadow is made in the direction in which area-light 3a differs from area-light 3b, it is desirable to install area-light 3a and area-light 3b so that the direction of the shadow of the connector pin 2 may serve as 90 degrees of abbreviation.
[0014] CCD camera 4 is arranged above a printed circuit board 1, and the shadow of the connector pin 2 made on a printed circuit board 1 by this CCD camera 4 is picturized from a direction perpendicular to a printed circuit board 1. A/D converter 5 quantizes, and the picture signal by the image pick-up of CCD camera 4 is changed into binary image data, and is memorized in an image memory 6. These processings are performed by being controlled by CPU7.
[0015] Drawing 2 is the mimetic diagram showing signs that the shadow of a connector pin is projected on a printed circuit board by the light from the area light concerning the optical inspection approach and optical test equipment of this invention. The light from an area light 3 is irradiated from the slanting upper part so that it may become an include angle theta 1 to a printed circuit board 1. Thereby, the shadow of the connector pin 2 is made on a printed circuit board 1, and the printed circuit board 1 on which the shadow of the connector pin 2 is projected by CCD camera 4 is picturized from above. In this way, the condition of the connector pin 2 is inspected by detecting the tip location of the shadow of the connector pin 2 from the picturized image, and the good/defect of the connector pin 2 are judged.
[0016] Light is irradiated from a different 2-way to the connector pin 2, and the shadow of the connector pin 2 is made on a printed circuit board 1, and by picturizing the situation with CCD camera 4, and analyzing the image, even if the connector pin 2 has bent in which direction, it becomes detectable [the deflection]. When the 2-way which irradiates light was a different direction in a field parallel to a printed circuit board 1 at this time and the 2-way which irradiates light is made perpendicular as shown in drawing 1 although detection of the deflection of the connector pin 2 is possible, the precision of detection of the deflection of the connector pin 2 becomes the highest.
[0017] In addition, it is more desirable to use the surface light source, although it is also possible to use the point light source as lighting which projects the shadow of the connector pin 2 on a printed circuit board 1. By using an area light 3, in every part in the image obtained by CCD camera 4 as area, the shadow of the connector pin 2 is formed in the fixed direction, and inspection becomes possible on the same conditions about the connector pin 2 in area.
[0018] In order to adjust the die length of the shadow of the connector pin 2, moreover, the optical inspection approach and optical test equipment of this invention It carries out based on the data of the pitch of the connector pin 2 of X and each Y shaft orientations, and the die length of the connector pin 2. An include angle with the optimal sense of the light

from the area light 3 within a field perpendicular to a printed circuit board is computed by using following formula **, and it has an accommodation means whenever [automatic lighting vertical plane interior angle / which adjusts the location of an area light 3 automatically so that it may be set as the optimal include angle]. In addition, calculation of these lighting include angles and a setup of a lighting include angle are performed by control of CPU.
theta1=tan {L/(P-alpha)} -- **, however L are [the pitch of the connector pin 2 and alpha of the die length of the connector pin 2 and P] the buffer die length for inspection allowances. Thereby, when the connector pin 2 is arranged two-dimensional, the shadow of the connector pin 2 becomes longer than the pitch of the connector pin 2, and it can prevent lapping with the connector pin 2 by which the tip location of the shadow adjoins.
[0019] Furthermore, it becomes possible by moving an area light 3 into a field parallel to a printed circuit board 1 to change the direction of the shadow of the connector pin 2. Drawing 4 is the mimetic diagram showing signs that the array of X of the connector pin concerning the optical inspection approach and optical test equipment of this invention and Y shaft orientations made the shadow in the different direction. Like drawing 4 , it is more possible to make a long shadow, without being influenced of the connector pin 2 by which the way which irradiates light adjoins in the direction of slant rather than irradiating light in the same direction as the list (X, Y shaft orientations) of the connector pin 2 in every direction. If the shadow of the connector pin 2 is made inside the quadrilateral which four connector pins 2 shown at this time, for example, drawing 4 , make, and a shadow is made so that it may be extended toward the vertical angle of a quadrilateral, the shadow of the connector pin 2 will become the longest and the precision of a judgment of the good/defect of the connector pin 2 will improve.
[0020] In order to adjust the direction of the shadow of the connector pin 2, moreover, the optical inspection approach and optical test equipment of this invention It carries out based on the data of the pitch of the connector pin 2 of X and each Y shaft orientations, and the die length of the connector pin 2. An include angle with the optimal sense of the light from the area light 3 within a field parallel to a printed circuit board is computed by using following formula **, and it has an accommodation means whenever [automatic lighting horizontal plane interior angle / which adjusts the location of an area light 3 automatically so that it may be set as the optimal include angle]. In addition, calculation of these lighting include angles and a setup of a lighting include angle are performed by control of CPU.
theta2=tan (PX/PY) -- **, however PX and PY are the pitches of the connector pin 2 of X shaft orientations and Y shaft orientations.
[0021] Moreover, white may be painted into the part on which the shadow of the connector pin 2 on a printed circuit board 1 is projected. Thereby, with lighting, the shadow of the connector pin 2 projected on a printed circuit board 1 becomes clearer, and the precision of a judgment of the good/defect of the connector pin 2 improves.
[0022] Drawing 3 is the mimetic diagram showing the pattern of the shadow of a connector pin. The condition of the connector pin 2 is judged from the direction and die length of the shadow. Drawing 3 (a) is the mimetic diagram showing the pattern of the shadow of the connector pin inserted normally. It is based on the tip location of the shadow of this connector pin 2 inserted normally. If the tip location of the shadow of the connector pin 2 is within the limits of predetermined [centering on predetermined criteria], it can be judged that the connector pin 2 is inserted normally. On the other hand, when there is a tip location of the shadow of the connector pin 2 out of range [predetermined], it is judged that the connector pin 2 is not inserted normally. It is the mimetic diagram showing an example of the shadow of the connector pin of drawing 3 (b) and "deflection NG." As shown in drawing 3 (b), when the direction of the shadow of the connector pin 2 is outside tolerance to criteria, it is judged with "deflection NG." Drawing 3 (c) is the mimetic diagram showing an example of the shadow of the connector pin of "immersion-depth NG." With [as shown in drawing 3 (c) / the die length of the shadow of the connector pin 2] tolerance [under], it is judged with "immersion-depth NG." Drawing 3 (d) is the mimetic diagram showing an example of the shadow of the connector pin which "is not inserted [NG]." As shown in drawing 3 (d), when there is no shadow of the connector pin 2, it is judged with "Un-inserting [NG]."
[0023] Moreover, even when the connector pin 2 is a random array in the optical inspection approach and optical test equipment of this invention or the connector pin 2 of random die length is intermingled, it is possible to inspect whether the connector pin 2 is inserted normally. That is, when analyzing the image pick-up image of the shadow of the connector pin 2, it becomes possible to inspect the condition of each connector pin 2, respectively by setting up the predetermined range where the tip location of the shadow should exist about each connector pin 2. Moreover, it is also possible to make two shadows of the connector pin 2 from a different 2-way in the direction which applies light to coincidence and is different, to picturize the location of the shadow, and to inspect the deflection of a different 2-way based on the image pick-up image, distortion, etc.
[0024] Next, the flow chart concerning use of the optical inspection approach of this invention and optical test equipment is explained. Drawing 5 is the flow chart of the gestalt of the 1 operation concerning the optical inspection

approach and optical test equipment of this invention. In step S1, lighting 3a (X shaft orientations) is turned on. Thereby, the shadow of the connector pin 2 is made by X shaft orientations. In step S2, the shadow of the connector pin 2 made by X shaft orientations on the printed circuit board 1 with CCD camera 4 is picturized from above. This image pick-up data is recorded on an image memory 6. In step S3, lighting 3a (X shaft orientations) is switched off. In step S4, lighting 3b (Y shaft orientations) is turned on. Thereby, the shadow of the connector pin 2 is made by Y shaft orientations. In step S5, the shadow of the connector pin 2 made by X shaft orientations on the printed circuit board 1 is picturized from above by CCD camera 4, and image pick-up data are recorded on an image memory 6. In step S6, lighting 3b (Y shaft orientations) is switched off.

[0025] In step S7, the tip location of the shadow of the connector pin 2 is detected based on the image inputted at step S2. Then, in step S8, whenever [corner of a street] is measured and the die length of the shadow of the connector pin 2 is measured in step S9. It is judged in step S10 whether the connector pin 2 is inserted normally. At this time, it is judged whether the connector pin 2 is in the condition of "deflection NG" shown in drawing 3 , whether it is in the condition of "immersion-depth NG", and whether it is in the condition of "not inserting [NG]." When the connector pin 2 was not inserted normally and it is judged at step S10, the location and the item of NG of the connector pin 2 (NG pin) judged to be NG are recorded in step S11. It is carried out until it is judged with measurement of all the connector pins 2 having ended the above step S7 - step S11 at step S12, and the deflection of analysis of the shadow of all the connector pins 2 made by X shaft orientations, i.e., Y shaft orientations of all the connector pins 2, and distortion are inspected.

[0026] In step S12, if judged with measurement of all the connector pins 2 having been completed, the step after step S13 will be performed continuously. At steps S13-S18, the same step as step S7 - step S12 is performed about the image inputted at step S5. That is, about all the connector pins 2, based on the image inputted at step S5, the tip location of the shadow of the connector pin 2 is detected at step S13, whenever [corner of a street / of the connector pin 2] is measured at step S14, the die length of the shadow of the connector pin 2 is measured at step S15, and it is judged whether the connector pin 2 is normally inserted at step S16. And in steps S13-S16, when judged with the connector pin 2 not being inserted normally, in step S17, the location and the item of NG of the connector pin 2 judged to be NG are recorded. It is carried out until it is judged with measurement of all the connector pins 2 having ended the above step S13 - step S17 at step S18, and the deflection of analysis of the shadow of all the connector pins 2 made by Y shaft orientations, i.e., X shaft orientations of all the connector pins 2, and distortion are inspected. When measurement of all the connector pins 2 is completed, press fit inspection is ended.

[0027] By the printed circuit board 1 in which the connector pin 2 is not inserted normally, the location and the item of NG of NG pin are recorded at step S11 or step S17. Although the printed circuit board 1 in which NG pin exists is a defective and it needs to be made different from an excellent article, the printed circuit board 1 judged depending on the item of NG to be a defective is reusable. For example, since the connector pin of "deflection NG" and "immersion-depth NG" is considered that insertion of the connector pin 2 was not performed normally by the fault of insertion pressure, the path of insertion, etc., it can make an excellent article by reinserting NG pin again. It is impossible to reuse on the other hand, since it is thought that the magnitude of a through hole is large and the printed circuit board 1 judged "Un-inserting [NG]" cannot fix the connector pin 2.

[0028] In the optical inspection approach and optical test equipment of this invention, analysis of the image pick-up data which applied light from two different directions and picturized the shadow of the connector pin 2 is independent in each direction. Therefore, after analyzing the image data recorded on the image memory 6 at step S2 at steps S7-S12, it is also possible to analyze the image data which performed step S4 and step S5, and was recorded on the image memory 6 at step S5 at steps S13-S18.

[0029] Moreover, although the good/defect of the connector pin 2 pressed fit in the printed circuit board 1 which has the through hole arranged by the press fit two-dimensional are inspected with the gestalt of the above-mentioned implementation This invention can be applied to a thin base material, a base material with bulk like the plinth of a connector, etc. also in inspection of the inspected member in which the letter member of a projection was arranged, without being limited to inspection of the good/defect of the connector pin 2 pressed fit in the printed circuit board 1.

[0030]

[Effect of the Invention] As opposed to base materials, such as a printed circuit board in which letter members of a projection, such as a connector pin, are pressed fit according to this invention as explained above Apply light from an one direction, picturize the shadow of the letter member of a projection projected on the base material made by the light with a CCD camera, apply light from a further different direction, and the shadow of the letter member of a projection is picturized similarly. In this way, since the configuration of the letter member of a projection is judged from the shadow of the picturized letter member of a projection, two or more letter members of a projection arranged so that a

projection might be extended to an abbreviation perpendicular direction to a base material become possible [inspecting whether it is inserted so that it may become a desired configuration].

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CLAIMS

[Claim(s)]
[Claim 1] The configuration of two or more letter parts of a projection arranged on said base material so that a projection might be extended to an abbreviation perpendicular direction to a base material and said base material is inspected optically. In order to be the optical inspection approach of judging the quality of the inspected member which has said letter part of a projection and to make the 1st shadow of said letter part of a projection on said base material The step which irradiates light from a predetermined include angle at said inspected member using the 1st light source, said 1st shadow -- said base material -- receiving -- abbreviation -- with the 1st image pick-up step picturized from a perpendicular direction In order to make the 2nd shadow of said letter part of a projection from the image pick-up image picturized at said 1st image pick-up step the step which detects the tip location of said 1st shadow, and on said base material So that a different part from the part irradiated at said 1st image pick-up step of said projection may be irradiated using the 2nd light source The step which applies light from an include angle which is different from said predetermined include angle in said inspected member, said 2nd shadow -- said base material -- receiving -- abbreviation -- with the 2nd image pick-up step picturized from a perpendicular direction The optical inspection approach of having the step which detects the tip location of said 2nd shadow from the image pick-up image picturized at said 2nd image pick-up step, and the step which judges the good/defect of said inspected member based on each tip location of said 1st and 2nd detected shadows.
[Claim 2] The optical inspection approach according to claim 1 characterized by said predetermined include angle and a different include angle being said predetermined include angle and an include angle different [90 degrees of abbreviation].
[Claim 3] The optical inspection approach according to claim 1 or 2 characterized by said 1st and 2nd light sources being the surface light source.
[Claim 4] The optical inspection approach according to claim 1 to 3 characterized by adjusting automatically the location of said 1st or 2nd light source so that the sense of the optimal light may be computed based on spacing of said letter part of a projection, and the die length of said letter part of a projection and said inspected member may be irradiated from the sense of said optimal light, in order to adjust the die length of the shadow of said letter part of a projection.
[Claim 5] The configuration of two or more letter parts of a projection arranged on said base material so that a projection might be extended to an abbreviation perpendicular direction to a base material and said base material is inspected optically. In order to be the optical inspection approach of judging the quality of the inspected member which has said letter part of a projection and to make the 1st shadow of said letter part of a projection on said base material In order to make the 2nd shadow of said letter part of a projection from a predetermined include angle to said inspected member the 1st lighting means which irradiates light, and on said base material So that a different part from the part irradiated at said 1st image pick-up step of said projection may be irradiated The 2nd lighting means which irradiates light from an include angle which is different from said predetermined include angle in said inspected member, said each 1st and 2nd shadows -- said base material -- receiving -- abbreviation -- with the image pick-up means for picturizing from a perpendicular direction Optical test equipment which has a detection means to detect each tip location of said 1st and 2nd shadows from the image pick-up image picturized by said image pick-up means, and a judgment means to judge the good/defect of said inspected member based on each tip location of said 1st and 2nd detected shadows.
[Claim 6] Optical test equipment according to claim 5 characterized by said predetermined include angle and a different include angle being said predetermined include angle and an include angle different [90 degrees of abbreviation].
[Claim 7] Optical test equipment according to claim 5 or 6 characterized by said 1st and 2nd lighting means being the

surface light source.

[Claim 8] Optical test equipment according to claim 5 to 7 characterized by adjusting automatically the location of said 1st or 2nd lighting means so that the sense of the optimal light may be computed based on spacing of said letter part of a projection, and the die length of said letter part of a projection and said inspected member may be irradiated from the sense of said optimal light, in order to adjust the die length of the shadow of said letter part of a projection.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the mimetic diagram showing the gestalt of the 1 operation concerning the optical inspection approach and optical test equipment of this invention.
[Drawing 2] It is the mimetic diagram showing signs that the shadow of a connector pin is projected on a printed circuit board by the light from the area light concerning the optical inspection approach and optical test equipment of this invention.
[Drawing 3] (a) is the mimetic diagram showing the pattern of the shadow of the connector pin inserted normally. (b) is the mimetic diagram showing an example of the shadow of the connector pin of "deflection NG." (c) is the mimetic diagram showing an example of the shadow of the connector pin of "immersion-depth NG." (d) is the mimetic diagram showing an example of the shadow of the connector pin which "is not inserted [NG]."
[Drawing 4] The array of X of the connector pin concerning the optical inspection approach and optical test equipment of this invention and Y shaft orientations is the mimetic diagram showing signs that the shadow was made in the different direction.
[Drawing 5] It is the flow chart of the gestalt of the 1 operation concerning the optical inspection approach and optical test equipment of this invention.
[Drawing 6] It is the mimetic diagram showing an example of the conventional press fit inspection approach.
[Drawing 7] It is the mimetic diagram showing other examples of the conventional press fit inspection approach.
[Description of Notations]
1 Printed Circuit Board (Base Material)
2 Connector Pin (Letter Member of Projection)
3 Area Light
4 CCD Camera
5 A/D Converter
6 Image Memory
7 CPU

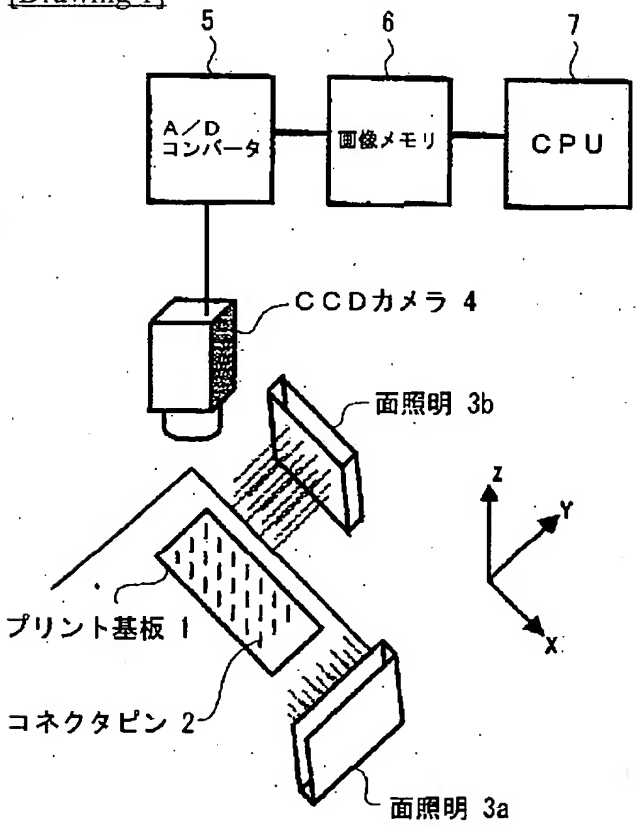
[Translation done.]

* NOTICES *

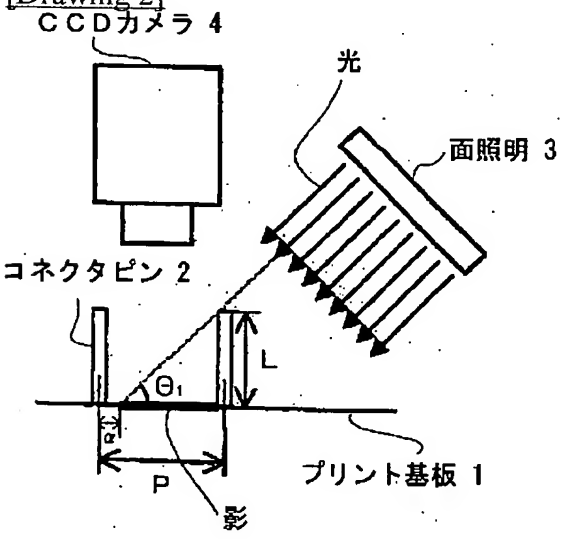
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

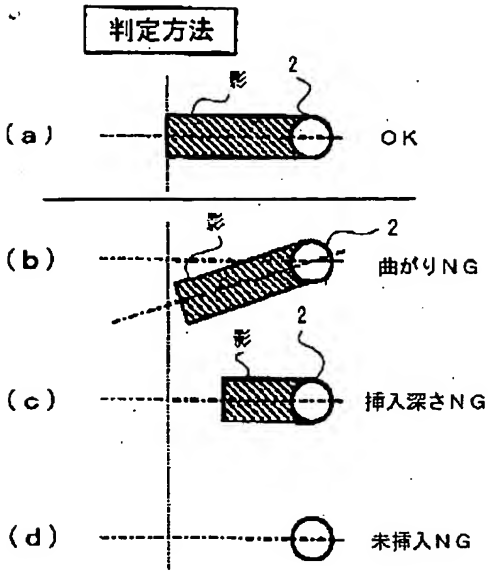
[Drawing 1]



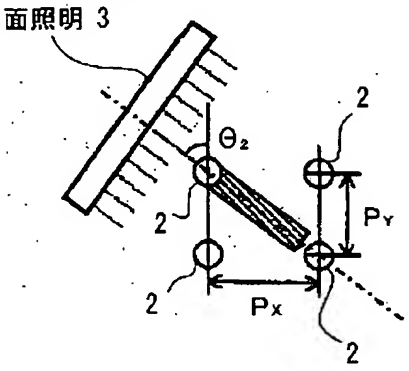
[Drawing 2]



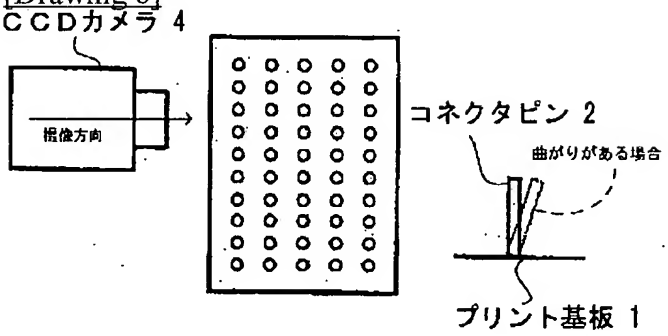
[Drawing 3]



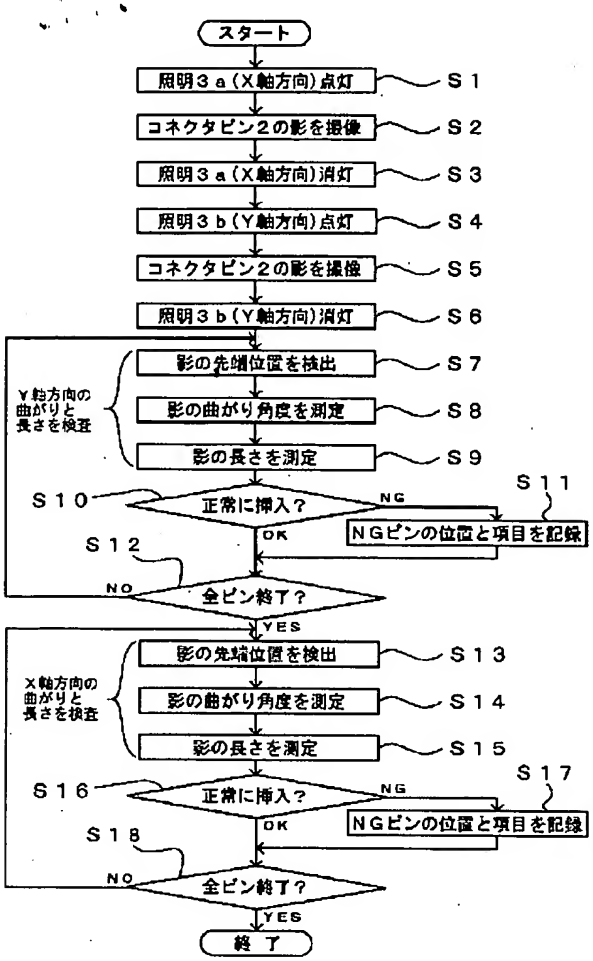
[Drawing 4]



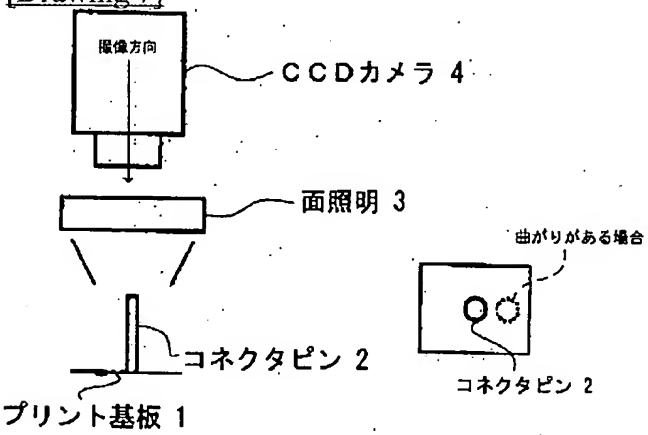
[Drawing 6]



[Drawing 5]



[Drawing 7]



[Translation done.]